FY-2002 PROPOSED SCOPE OF WORK for: Project No.: 85D

Monitoring of Sediment Deposition and Erosion

Lead Agency:	U. S. Fish and Wildlife Service
Submitted By:	Division of Water Resources
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Category:	Expected Funding Source:
_ Ongoing project	_ Annual funds
X Ongoing-revised project	_ Capital funds
_ Requested new project	X O&M funds
_ Unsolicited proposal	

I. Title of Proposal: Time-Series Monitoring of Deposition and Erosion at the Jensen Razorback Sucker Spawning Bar.

II. Relation to RIPRAP:

Green River Action Plan: Mainstem

I.A.3.a Operate Reservoirs Pursuant to Biological Opinions

III. Study Background/Rationale and Hypotheses:

Background:

The Recovery Program has implemented a program to help reproduce a more natural hydrograph on the Green River below Flaming Gorge Dam to benefit endangered fish. The 1990 Flaming Gorge biological opinion and the recently released Flaming Gorge synthesis report both contain recommendations for matching the peak of the Yampa River with artificial peak flow from Flaming Gorge to create a more natural hydrograph for the Green River. The objective of the effort is to maintain active, complex channel characteristics and spawning bars, and to create conditions which clean fine-grained sediments from cobble substrates at spawning bars.

Rationale:

Currently, evaluating the benefits of Flaming Gorge Biological Opinion releases in terms of biological response of adult endangered fish populations is difficult because it takes several years for enhanced production of young to show up in adult populations. Physical monitoring programs are complicated by the effects of local storms on sedimentation and the staff resources required to conduct repeated surveys in a timely fashion to evaluate effects of enhanced peak flows. What is needed is a methodology that continuously monitors sedimentation and erosion at complex habitat sites in response to flow enhancement and natural cycles.

Razorback sucker spawn pre-peak in cobble side channels that have been cleaned of overlying sand deposits during the previous year's declining flow and base flow period. Razorback suckers must spawn, resulting eggs must hatch, and larvae must emerge from spawning cobbles before peak flows that result in severe backwater conditions and sand deposition at the spawning locations (Wick, 1997). At spawning sites identified thus far, river constriction and/or sharp bending downstream from expansion zone bar deposits cause the water surface slope to decline at high peak flows. Velocities are reduced and deposition of bed load occurs.

Hypotheses:

The movement of bed materials can be monitored as time-series and related to biological processes such as spawning and emergence of endangered fish larvae. To explore this hypothesis we propose to use load-cell scour sensors (Carpenter, 1996) to monitor bed material transport, deposition, and scour to study the relationship between flow regimen and sediment transport in habitats of endangered fish production and recruitment. We propose to upgrade monitoring sites at the Jensen Razorback sucker spawning bar which was established in 1998 using funding from the office of Technology Transfer and support from the National Park Service and the Fish and Wildlife Service.

Physical data collected at the Jensen spawning sites of endangered fishes should be evaluated in conjunction with biological response data from light traps and drift samples. A comparison of the physical data response of cobble deposition and reconditioning of spawning sites with biological response of larval production enables determination of the effect of flaming Gorge operations on larval production. Hopefully, high larval production years can be tracked by following the cohort or through other standardized monitoring or population evaluation programs, thus eventually attributing a positive population response to flow management action. The Recovery Program is evaluating the need to reinstate larval-monitoring programs based on an impending evaluation report. Our proposed work should benefit from any biological response data available which could help determine the effects of periodical maintenance of clean cobble pre and post spawning. We believe that we can accurately measure bed material elevation at primary bar locations. We believe that active channel bed movement resulting in properly timed deposition and erosion at spawning sites will result in improved fish production and ultimately improve adult fish numbers. We hope that razorback larval monitoring will be continued on the Green River because knowledge of when larvae enter the river is critical information in the flow management process.

IV. Study Goals and Objectives:

Goal:

The goal of the work is to develop a means to quantify sediment dynamics at a site and relate that information to a physical and biological process which create habitat for endangered fish.

Objectives:

1. Use load-cell scour sensors to monitor bed material transport, deposition, and scour at habitats that are important to endangered fish.

2. Develop guidelines for real-time management of Flaming Gorge Reservoir.

3. Identify relationships between the physical processes and the biological response at each site.

4. Evaluate annual flow management activities (Flaming Gorge Spring Operations) that target improvements in endangered fish production and recruitment.

V. Study Area:

Green River Basin. The equipment will be located in spawning bars on the Green River at the following locations:

1. The Jensen razorback spawning bar at RM 311 on the Green River;
2. The sand-storage channel 0.4 RM upstream from the razorback spawning bar at RM 311.

VI. Study Method/Approach:

Since August 1998, newly developed liquid-filled load cell scour sensors have been used to successfully monitor bed-load transport, deposition and erosion on razorback sucker spawning bars on the Green and Yampa Rivers (Carpenter et al., 1999). Deposition and erosion, as measured by the sensors at the razorback spawning bar, are consistent with HEC-6 modeling (Wick 1998) of the site using sediment data from the Jensen gage. The load-cell sensors documented passage of dunes and as much as 0.7 feet of sand deposition and erosion on the spawning bar during the latter half of the spawning period. Burial of historical spawning beds during a historical spawning period, combined with cold temperatures may have affected razorback spawning success (see Figure 1 below).

The load-cell sensor functions by weighing the sediment, water, and air above it; and an accompanying pore-pressure sensor weighs the water and air above it. The difference between the two weights is the weight of the sediment overlying the sensor pair. Combined sensitivity and repeatability are +/- 0.01 foot of sediment thickness or less. Sensor pairs are buried in the bar and hard wired to a data logger at the site to provide time series data. Accompanying temperature sensors record substrate temperature. An hourly sampling interval has been used so far, but the data indicate that a 15-minute sampling would provide additional detail on passage of bed forms. This is the only known technique that provides unattended time series of bed material transport. This technique has been mainly used to measure sand but can be applied to other combinations of bed material. Sonar and acoustic-Doppler channel surveying will be used as calibration checks of thickness of bed material above the sensors.

Beyond calibration checks of the load-cell sensors, data from sonar and acoustic-Doppler channel surveying, supplement data from the load-cell sensors. The load-cell sensors provide continuous time-series data of temperature and change in bed thickness at selected locations. Sonar and acoustic-Doppler provide flow conditions, velocity distribution, discharge, and bed configuration in a linear profile or areal array at a particular time. Together, the combination of techniques provides cross checks and much more information than either can separately. Moreover, the combination of techniques can reduce ambiguities regarding infilling and removal of fine-grained sediment among cobbles. Very small apparent changes in sediment load that are less than the mean diameter of the surface material suggest infilling. Lack of change in repeated precise acoustic-Doppler and sonar surveys would substantiate that inference.

Sensors will be placed and wires laid in hand-dug trenches to the datalogger boxes on the bank. Installations will be left to run through winter and visited prior to spring spawning in 2001 for data collection, maintenance, and repairs. Post-spawning data collection, maintenance, and repairs will be done during summer 2001 low flows.

The data consist of time-series of differences between total load sensors and pore-pressure sensors. Because the erosional and depositional environment is hard on sensors, intense scrutiny of the data has to be done to identify and remove bad data. This is done by plotting differences between a reference sensor and nearby sensors. Several different reference sensors are chosen, and in the process, bad sensors emerge. In some cases, records from nearby pore-pressure sensors can be substituted for ones that have failed. Adjusted and corrected data are time-series and plots in a spreadsheet. The sediment-thickness-change and temperature data are correlated with streamflow-gage data at the nearest USES streamflow gage, available sediment data, available acoustic-Doppler and sonar channel-survey data, and larval-emergence data for analysis of effectiveness of flow management.

VII. Tasks Description and Schedule:

1. Repair or replace 10 sensor pairs which are currently deployed on the Green River sites. Replace equipment on loan from USGS and NPS. The sediment load sensors will be repaired or replaced in mid-summer when flows are low.

2. Install real-time monitoring equipment so that the function of the sensors can be

monitored and sediment movement can be tracked.

3. Mike Carpenter of USGS will develop a data template and a web page where the data from the sensor can be view on a near real-time basis.

4. The sensor locations will be monitored during runoff with Sonar and acoustic-Doppler equipment to facilitate channel surveying which will be used as calibration checks of thickness of bed material above the sensors. This work will be coordinated with USGS Biological Research Division.

5. Each site will be visited in July of each year to service equipment and download data.

6. July through December 2001, graphs and reports on each site will be prepared. A database will be developed to store the sensor data. The data will be plotted, quality checked, and provided to the Recovery Program. A publishable report documenting the status of the effort and relating the sediment data to biological information and hydrographs from nearby USGS gages.

VIII. FY-2001 Budget:

Equipment and Installation
Capital Costs:

Sensors	7@ $2,000 ea.	$14,000
Data Loggers	2@ $1,250 ea.	2, 500
Multiplexers	2@ $ 550 ea.	1,100
Relay Modules	2@ $ 200 ea.	400
Batteries	6@ $ 40 ea.	240
Radios & Sundries	4@$ 1,250 ea.	5,000
Supplies		1,360
Total		$24,600

Non Capital Costs:

Salary:	USGS	$ 7,000
	Contractor	$ 2,000
Travel 3 trips @ $2,100 ea.		6,300
Total		$15,300
Grand Total		$39,900

FY-2002 Budget:

Sensor Maintenance	$15,000
Upgrade Remote Monitors	5,000
Contractor	3,000
Data Reduction & Report Preparation	15,000
Total	$38,000

FY-2003 Budget:

Sensor Maintenance	$15,000
Upgrade Remote Monitors	5,000
contractor	3,000
Data Reduction & Report Preparation	15,000
Total	$38,000

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IX. Reviewers: John Pitlick
Doug Osmundson

Most of the reviewers comments are not relevant to this revised proposal

X. References:

Harvey, M. D., Mussetter, R. A., and Wick, E. J., A Physical Process-Biological Response Model for Spawning Habitat Formation for Endangered Colorado Squawfish, Rivers 4 (2): 114-131

Osmundson D. R., Nelson P., Fenton K., Relationship Between Flow and Rare Fish Habitat in the 15-Mile Reach of the Upper Colorado River: Final report, May 1995. U.S. Fish and Wildlife Service.

Wick, E. J., 1997. Physical Processes and Habitat Critical to the Endangered Razorback Sucker on the Green River, Utah: Doctoral Dissertation, Colorado State University, Fort Collins.

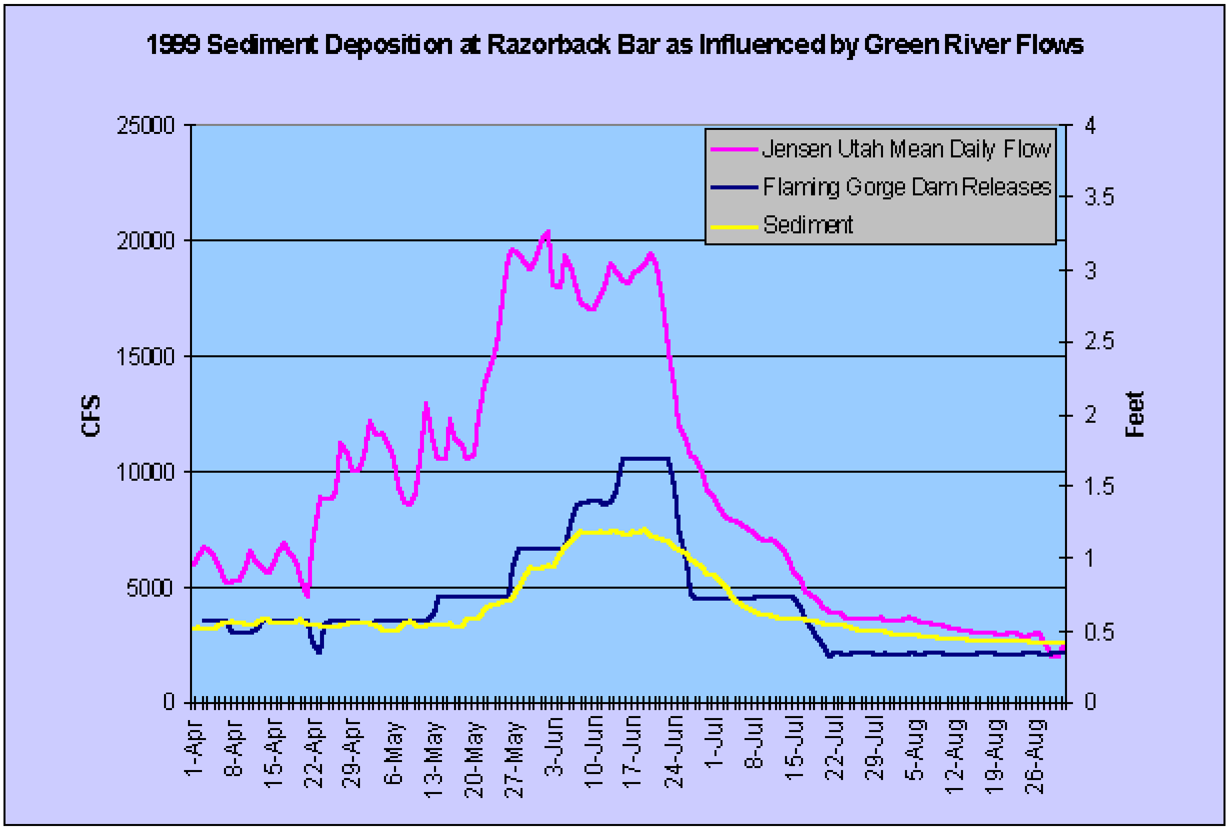
Carpenter, M. C., Crosswhite, J. A., and Marie, J. R., 1995, A Load-Cell Scour Sensor to Measure Erosion and Deposition in the Regulated Colorado River in the Grand Canyon, Arizona [abs.]: American Geophysical Union Transactions, v. 76, no. 46, p. F271.

Carpenter, M. C., 1996, Monitoring Erosion and Deposition Using an Array of Load-cell Scour Sensors During the Spring 1996 Controlled Flood Experiment on the Colorado River in the Grand Canyon, Arizona [abs.]: American Geophysical Union Transactions, v. 77, no., 46, p. F271.

Konieczki, A. D., Graf, J. B., and Carpenter, M. C., 1997, Streamflow and sediment data collected to determine the effects of a controlled flood in March and April 1996 on the Colorado River between Lees Ferry and Diamond Creek, Arizona: U.S. Geological Survey Open-File Report 97–224, p. 55

Carpenter, M. C., Lockett, J. L, Wick, E. J., Smith, G. R., Cluer, B. L., and Blomgren, N. P., 1999, Monitoring Sand Deposition and Erosion on Spawning Beds Used by Razorback Suckers on the Green River Downstream from Flaming Gorge Dam Using an Array of Load-Cell Scour Sensors [abs.]: American Geophysical Union Transactions, v. 80, no. 46, p. F448–F449.

FIGURE 1



1999 Sediment Deposition at Razorback Bar as Influenced by Green River Flows
Jensen Utah Mean Daily Flow
Flaming Gorge Dam Releases
Sediment
CFS
Feet
25000
20000
15000
10000
5000
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug